

FARM ELECTRIFICATION
MANUAL*Copyright 1956*EDISON ELECTRIC INSTITUTE
420 Lexington Ave., New York 17, N. Y.Section 5—Revised
FARM FREEZING

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GENERAL

Every farm with electric service is a potential user of some type of farm freezer. World War II has shown us that there can be food shortages in this country, that there are real values in home gardens and that we have many opportunities to improve the American diet. Preserving food in a near-fresh state by freezing can bring farm families food opportunities never before realized.

Farm freezers offer a double opportunity. One enables the family to enjoy quality food at any season of the year. The second encourages the development of farm enterprises, by making possible storage of the best fruits, vegetables, poultry, etc., at low prices in peak production periods. These, in turn, may be sold during out-of-season periods, or at times of public demand resulting in profits and more efficient use of available labor.

Some of the more important conditions contributing to increased interest in farm freezing are:

1. Increased use of home and commercially frozen foods.
2. Processing foods for freezing takes much less time than for other methods of food preservation.
3. Freezing is a safe, easy way to preserve fruit and vegetables, meat, fish, poultry, game, and baked or other pre-cooked foods.
4. Freezing will retain the original flavor, color, and nutritive value of food.
5. Freezers for home use are available in a variety of styles and sizes.
6. Freezing permits the homemaker more leisure time because of less food shopping, easier meal planning and preparation.

Public Appeal

The technique of freezing and storing foods at

low temperatures, developed and popularized by the commercial frozen foods industry and locker storage plants, has opened up new and wide possibilities for the preservation of the farm food supply. Among its advantages are:

1. *Frozen foods closely resemble the fresh product* in appearance and natural flavor. Freezing preserves the natural flavor.
2. *Freezing preserves healthful vitamins and minerals*, due to the short processing and cooking time required. Frozen foods have high nutritive value if quality raw products are used.
3. *Food freezing is easy*. Instructions are simple but important.
4. *Food freezing is economical*. Small quantities can be handled efficiently.
5. *Freezing preserves the farm's temporary surplus* and makes it possible to enjoy foods such as prime broilers over a longer period. Turkeys can be frozen when just the age preferred and then used as desired; several months later they will be just as good, and possibly better than older, freshly killed ones. There is no need to let birds or animals grow old and tough on the hoof.
6. *Frozen foods are easy to prepare* for serving and are easy to use. Nearly all the preparation preliminary to use has already been done, at a more appropriate time than during the rush of meal preparation.

Your Opportunities

Use of a locker plant, with a household refrigerator having a freezer compartment of about 3 cu-ft capacity, will probably offer the most practical frozen storage facilities for present needs of a small percentage of our farms. Small size freezers will meet the needs of another group. Freezers ranging from 15 to 30 cu ft will satisfy many more and will store the most important items.

There is a definite place for larger home freezing equipment, either individual freezer chests or freezer compartments, in above-freezing "reach-in" or "walk-in" farm refrigerators. The most promising field for development of this type of equipment at present is on the larger farms, ranches and country estates, as well as farms located a considerable distance from a locker plant.

Place of Freezing in Food Schedule

Of the 8,500 lbs of food ordinarily needed each year by a family of five, over 2,500 lbs of meat, poultry, sea food, fruits and vegetables can be preserved satisfactorily by freezing. But, even by staggering production throughout the year, it will rarely be possible to put more than 700 to 1,000 lbs of food

through a single 200-lb capacity locker in 12 months. A farm freezer is an excellent addition.

The whole family can help decide which foods to freeze and which to can, cure, dry or store in other ways. In most homes, beefsteak, pork chops, peas, asparagus and berries would probably have first call on the freezer storage space. The next choices would be beef roasts, pork loin, frying chickens, lima beans, corn, cherries and peaches.

If the year's food supply has been budgeted, foods for freezing may also be selected on a seasonal basis. Thus part of the March-stored beef will be out of the locker when space is needed for the summer rush of garden truck. In like manner, part of the fruits and vegetables will have been used, when room is needed for the meat from an October-dressed pig.

Ham, bacon and pork shoulders are good meats for curing. Beef stew, ground meat and older poultry are often canned.

Almost all vegetables may be canned successfully. A common procedure, however, is to can a smaller part of them and freeze the larger part for variety, as well as a better, tastier product.

Making preserves, jams and jellies will take care of part of the fruits to be preserved and will relieve pressure on the locker or home freezer. Some of the peaches, plums, cherries and grape juice can be canned and stored in the cellar. Root crops, cabbage and apples can be held in a ventilated cellar or cave.

Be sure that the farm family understands that other food preservation will supplement freezing once the customer preserves food by freezing.

WHICH FOODS TO FREEZE

The first foods frozen should be those that cannot be stored satisfactorily by other methods. Tomatoes and fruits are easily canned. Root vegetables may be stored in vegetable pits or cellars. However, such foods as cauliflower, broccoli, beans, peas, corn and meats must be handled with extra care if canned, and the processing directions carefully followed to prevent spoilage. These same foods can be easily and safely frozen, and taste more like the fresh products when eaten.

1. *Freeze These:* All vegetables such as beans, peas, etc., which are cooked before serving, will freeze well if properly prepared. Most fruits will freeze well, but those giving the best quality frozen product include blueberries, cherries, cranberries, gooseberries, peaches, raspberries and strawberries. Poultry, meats and fish make good frozen products.
2. *Don't Freeze These:* The salad green vegetables which are eaten raw, such as lettuce, celery, cabbage, cucumbers, onions, radishes and tomatoes.

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3. *These Foods Also Can Be Frozen:*

Game—If game is to be frozen, extra care should be taken in handling so that the meat will be in prime condition. Keep meat clean and cool. When prepared for use, wrap and freeze as with domestic meats.

Eggs—Freeze eggs when plentiful to assure an adequate future supply. Pack, either whole eggs, or whites and yolks separately. To assure smoother texture when thawed, add a small amount of salt, sugar, or corn syrup to egg yolks or whole eggs.

Fish—Fish should be placed on ice immediately after being caught and frozen as soon as possible. Prepare both fresh and

salt water fish ready for cooking. If fish is to be frozen whole, remove fins and tail. Wrap in moisture-vapor-proof paper or glaze.

Butter—Wrap in moisture- and vapor-proof paper. Seal and freeze. Even if butter is already wrapped as it comes from the creamery, it should also be wrapped in the freezer paper. Unsalted butter preserves better than salted butter.

Ice Cream—Home-made ice cream can be placed in moisture- and vapor-proof cartons and stored in the locker or home freezer. Or it may be purchased in quantity, repacked and the unused portion frozen and stored. Temperature should not be higher than 10 F.

PRESENT FOOD-FREEZING SERVICES AVAILABLE TO FARMERS

Facilities for freezing meats, fruits, vegetables and other suitable foods at low temperatures (0 F to -40 F), and storing at temperatures from 0 F to -10 F are available to farm people through centrally located locker storage plants; through refrigeration units designed for individual farm use, or a combination of the two. The more common practices in using these facilities are:

1. Using central locker plant for processing, freezing and storage—no refrigeration equipment on farm.

Advantages: No investment in equipment.

Disadvantages: Trip to locker plant required each time frozen foods are needed. This method is not practical except when user lives only a short distance from locker plant, or when arrangements can be made for home delivery of frozen food—as in case of milk, cream or egg routes operated from locker plant.

2. Using central locker plant for processing, freezing and storing, and the standard household refrigerator with oversize freezer compartment (2 to 10 lbs capacity or more) for storing a few days' supply at the farm.

Advantages:

- Low investment.
- Less chance of losses because of equipment failure.
- Greater flexibility of operation.
- Less labor required in processing, wrapping, freezing and storing.
- Probable better quality food because of ability of plant operator and facilities available.

Disadvantages:

Frequent trips to the locker plant required.

Small storage space at home makes it difficult to keep a variety of products on hand.

Storage cost may be higher in case of large volume.

Cash outlay for processing higher than if home facilities available.

3. Using central locker plant for processing, freezing and storage, and the household refrigerator with large (1 to 6 cu ft) freezer compartment which will hold one to two weeks' supply of frozen foods on the farm. (The large freezer compartment in this type of refrigerator is suitable for freezing small quantities of products on the farm.)

Advantages and disadvantages same as for 2 above. The larger freezer compartment in the home refrigerator, however, permits storing a greater variety of products on the farm, reduces storage cost at the locker plant, permits freezing of small quantities of products at the farm, and reduces frequency of visits to locker plants.

4. Using the individual farm freezer chest, of fairly large size, for freezing and storage on the farm—with some chilling and freezing done at locker plant in summer months.

Advantages:

- Eliminates necessity of frequent trips to locker plant.
- Provides complete variety of products for immediate use.



Fig. 1—Chest-type freezer for storing frozen foods.

Possible lower cost with larger volume of products.

Affords freezing facilities for fruits, vegetables and poultry on the farm; also for freezing mutton, beef and pork when "outside" temperature is low enough for removing animal heat.

Lower processing cost since labor for cutting and wrapping is provided on the farm.

Disadvantages:

Chance for losses due to equipment failure.

More labor required.

Probable higher cost in case of small volume.

No space available at normal temperatures (32 F to 40 F) for chilling and for short-time storage.

5. Using the all-purpose farm refrigerator which has complete facilities for chilling, freezing and storage at the farm.

Advantages:

Facilities available for all requirements, including chilling and storage at 32 F to 40 F, and freezing and storage at 0 F to -10 F.

Eliminates trips to the locker plant.

Possible lower cost in case of large volume.

Affords numerous opportunities for increasing farm income through sale of better quality products, such as eggs, cream, poultry and vegetables,

which may be stored in the above-freezing compartment.

Disadvantages:

Large initial investment.

Chance for losses due to equipment failure.

Possible higher cost in case of small volume.

More labor required.

6. Buy food at retail as needed, or use frozen-food delivery service. In several areas weekly deliveries of frozen foods are made to customers by frozen-food locker plants and retail food stores. In some cases frozen-food units, ranging in size from 3½ to 6 cu ft, are supplied by the establishment supplying the frozen food. This type service can easily be extended into semi-rural areas.

OPERATING COSTS

The operating cost of a frozen-food unit depends upon the efficiency of its insulation; room temperature; size of the unit; amount of food frozen; how often the box is opened; temperature at which the unit is operated and, of course, the cost of electrical energy.

The size of the compressor has but little effect on the cost of operation. Small freezer units have greater outside area per cubic foot of space and usually are not as well insulated as larger units; therefore, the power consumption per cubic foot of space for small units is greater than for larger and better insulated units.

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New and well-built cabinets, with 5 inches of insulation, may be expected to use about the following amounts of electrical energy:

Size, Cu Ft	Average Kwhr per Month
2	40
4 to 6	60
8 to 12	80
15 to 25	100

Cabinets with less insulation may be expected to use more electricity. Freezing costs will vary with the type and temperature of the product, and the temperature of the room in which the compressor is located. The cost of freezing, however, is insignificant compared with the cost of holding the food in storage at a temperature of zero. For instance, 1,000 lbs of food can be frozen for what it costs to maintain a storage temperature of zero in a standard 20-cu ft cabinet for 10 summer days.

WHAT A FREEZER SHOULD DO

A farm freezer is built to do an entirely different

job than a household refrigerator, ice cream cabinet or a milk cooler, and should, therefore, be selected on its merits for the work it is supposed to do.

1. It should have enough storage capacity for the average needs of the particular farm family.
2. It should be convenient to use, and built for years of service.
3. It should occupy a minimum of floor space and go through the average door.
4. It should not only store food, but should be able to freeze at least 50 lbs of food a day for a 15-cu ft cabinet, and larger amounts for larger cabinets. It should be easy to defrost.
5. It should maintain a temperature of zero or below at all times during storage conditions, with minimum temperature variation and at low operating cost.
6. It should be as foolproof as possible. A warning signal and possibly door locks should be incorporated. Service should be available within a few hours.
7. The freezer you recommend should be manufactured by a reputable concern and be guaranteed against mechanical defects.

FARM-FREEZING EQUIPMENT

CHOICE OF TYPE AND SIZE

Type

A frozen food unit may be designed to both freeze and store, or only to store frozen food. So-called freezing units will differ from storage units in that one compartment is insulated from the others, and is equipped with sufficient evaporator surface to prevent a rise in temperature when loaded to its rated freezing capacity with warm products. The remainder of the box is used for storage.

Units designed to freeze as well as store are usually larger than 8 to 10 cu ft capacity.

For any given cubical content, the front-opening type requires less floor space than the chest type. Because of its shape, a larger capacity cabinet of the front-opening type can be moved through a doorway. Some front-opening units are equipped with drawers, which add to the convenience. More frequent defrosting is necessary with the front-opening type, because of the loss of cold air and admission of warm air when the doors are opened. However, some front-opening models are more easily defrosted than certain units of the chest type.

Household frozen-food storage units, ranging in size from 3 to 8-cu ft capacity, are ideal for tem-

porary storage and represent the minimum requirement, if a wide variety of frozen foods is to be kept on hand.

Farm frozen-food storage units of one temperature, with 10 to 15 or 20 cu ft capacity, represent the minimum requirement for farm use, if no additional storage space is used. Freezing more than 25 or 30 lbs of products at a time is not recommended with this type of equipment. Amounts greater than 25 or 30 lbs should be frozen at the local frozen food locker plant if possible.

Farm freezers with a freezer section are usually 15 to 40 cu ft or larger. Both chest and front-opening types are available. The farm freezer represents a slightly higher investment than a storage cabinet, because of the added equipment. This type unit is desirable if large quantities of products, especially meat, are frozen at a time. It will give results usually superior to those obtained when large quantities of food are frozen and stored in a cabinet not equipped with a freezing compartment.

Some units have a household refrigeration compartment, held at approximately 40 F, a small freezing compartment, held at a few degrees below zero, and a 0 F storage compartment. For convenience, this unit should be in or near the kitchen.

A walk-in frozen food unit is suggested for a

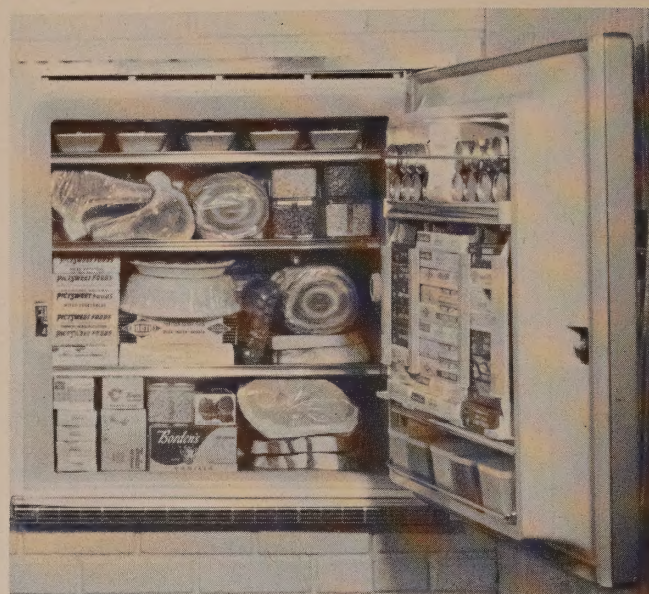


Fig. 2 (Left)—Front opening type 13.4 cu-ft food freezer equipped with handy door-type storage shelves.

Fig. 3 (Above)—Built-in food freezer holds about 230 lb of frozen food. Its door has racks for storing standard frozen food packages, frozen juice bar and a shelf of five plastic re-usable containers for left-overs.

specialized program, such as freezing and holding large quantities of poultry, meats, and other foods.

Manufactured units consisting of a walk-in chill room, a freezing compartment and a frozen-food storage compartment are available. The compartment for frozen foods ranges from 20 to 60 cu ft. Some of these units have a chill room large enough to cool a side of beef.

Some farm customers may prefer to use two or three freezers in the farm home. Since the space required for freezing varies during the year, all of the units may be in use part of the time; at other periods, only one unit will be needed. This reduces the operating cost and also makes it possible to use one unit as a quick freeze, when it is not needed for regular storage.

The use of several smaller units permits the farmer to move them about easily, and thus encourages their use by tenant farmers. Also, a possible failure of one unit does not jeopardize the entire frozen-food supply.

Size

The economical use of the freezing unit depends largely on a constant turnover of its contents. For a farm family this will mean using during the winter all the fruits and vegetables frozen the previous summer, and using practically all the meat from one kind of animal before replacing the supply. Certain meats do not keep as long as others in frozen storage and should be used first. Frozen pork keeps for only four or five months, while frozen lamb and

beef may be kept longer periods. Ground meat of any kind, especially seasoned sausage, should be used first, because it does not keep as long as other kinds. Adding salt to meat before freezing is not recommended since it greatly shortens the storage period. Fish should be used within 3 or 4 months after freezing.

The produce available, as well as the likes and dislikes of the family, will govern the quantity of each item chosen for freezing. When some items are unavailable, increased amounts of the others will make up the total for the month.

For Farm Families

In order to freeze and store the average amount of food generally accepted for a family of four, a frozen-food unit having a capacity of 25 cu ft is recommended, or 6 cu ft per person. This capacity will be sufficient only if food is withdrawn from the frozen-food unit according to the suggestions already given.

It should be noted that if all the food for a family of four were stored at the same time, a unit with a capacity of approximately 40 cu ft may be required. However, because of constant withdrawals, the greatest amount of food stored in the unit at one time is approximately two-thirds of the total; hence, the unit should be large enough to hold approximately two-thirds of the total volume of food frozen per year.

When a suggested freezing program is available, the following tables will aid you in determining the size to recommend.

For Town Families

It is more difficult to suggest a plan for a non-farm family wishing to purchase a freezer because of the varied opportunities such families have for cultivating a garden or for purchasing food to be frozen. Freezing fruits and vegetables that have been shipped for long distances after harvest, or that are of unknown variety, is not recommended.

In deciding whether to purchase a home freezer, the urban family will need to consider the possibility of obtaining suitable fruits and vegetables for freezing, and of buying meat wholesale, as well as the requirements for temporary storage of food purchased already frozen. If the family decides to purchase a frozen-food unit, an estimate of the size needed may be made from Table I.

Table I shows how many pint and quart containers of various types can be stored in a cubic foot of storage space, and Table II gives the pounds of meat obtainable from animals of average size. It would seem that the logical way to determine the size of the frozen food unit is to plan the use to be made of the unit.

be moved to the desired location.

A dry basement usually is most desirable for the frozen-food unit. The temperature never reaches the extremes of other parts of the home during the summer. The basement floor is solid, so noise and vibrations are not noticeable in other parts of the home. Usually there is more room available around the unit for work space. One objection is the difficulty of getting the unit into the basement. This should be checked on before a unit is purchased.

A garage, especially if attached to the house, offers a good location. The temperature will be higher than in the basement during the summer months, but the average for the year will be lower. With some units, precautions described by the manufacturer are necessary if room temperature drops below 30 F. The utility room offers another possible location for the unit.

INSTALLATION SUGGESTIONS

The frozen-food unit should rest on a firm, level floor. Enough space should be provided around it to allow for free circulation of air to motor and con-

TABLE I—APPROXIMATE NUMBER OF PACKAGES TO FILL ONE CUBIC FOOT OF FREEZER STORAGE SPACE

Type of Container	Pints		Quarts	
	Dimensions, In.	Number per Cu ft	Dimensions, In.	Number per Cu ft
Round tub		16		8
Waxed rectangular carton without liner	$3\frac{1}{4} \times 3\frac{1}{4} \times 3$	44	$3\frac{1}{4} \times 3\frac{1}{4} \times 5\frac{3}{4}$	22
Rectangular carton with liner	$4 \times 5\frac{1}{4} \times 1\frac{3}{4}$	38	$5\frac{1}{4} \times 5\frac{1}{4} \times 2\frac{1}{4}$	20
Rectangular carton with liner	$4 \times 3\frac{1}{4} \times 2$	37	$4 \times 7\frac{1}{4} \times 2$	24

TABLE II—LIVE, DRESSED AND PACKAGED WEIGHTS OF THE VARIOUS MEATS*

Age	Live Weight, Lbs	Dressed Weight, Lbs	Packaged Weight $\frac{1}{2}$ of Car- cass, Lbs†
Cattle—1 to 2 years	600–1,000	300–600	240
Veal—4 to 8 weeks	150–200	80–120	31
Hogs—6 to 8 months	180–250	135–200	90‡
Lambs—5 to 6 months	80–100	36–50	20

* The weight of packaged meat will be less if some bones are removed.

† Based on maximum weight given under column headed "Dressed Weight."

‡ Including fat pork used for lard.

LOCATION

In general, any cool, dry, well-ventilated location out of the direct rays of the sun is suitable. Finding a suitable location may present some problems, such as: Will the floor support it? Will there be room for circulation of air around the refrigeration unit? Is it possible to get a unit of a desired size through the doors, hallways or stairs? It may be advisable to construct a light, wood frame of the width and length of the unit being considered, to see if it can

denser. It should be conveniently located. A work space near the unit is desirable.

If an electric outlet is not convenient, a separate circuit can be installed. If the motor is one-half hp or larger, a separate circuit should always be recommended. A separate circuit makes it possible to fuse the circuit to protect the motor from damage by an overload current. In no case should an attempt be made to connect a unit to an overloaded circuit.

A duplex convenience outlet should be recommended, and located so that one can easily see if the unit is plugged in. With a duplex outlet there is no necessity of disconnecting the unit in order to utilize the outlet for other purposes, such as heating an iron to seal packages, if this is done at the freezer location.

If the motor is neither equipped with built-in motor protection nor used on a separate circuit, some other provision should be made to protect the motor from damage by an overload current.

Motors should be oiled according to the manufacturer's recommendations. The hinges and latches should be oiled frequently to insure satisfactory operation and to prevent rusting. No other parts re-

quire lubrication with the possible exception of the freezing compartment fan. Follow manufacturer's recommendation carefully. Recommend that the electric attachment plug be disconnected before oiling or cleaning any part of the refrigerating unit, and suggest that the cord be placed in a conspicuous place as a reminder to plug it in when the job is completed.

The motor and condenser should be cleaned with a cloth, whiskbroom or vacuum cleaner attachment every three or four months, or as often as necessary to keep the parts free from dust and lint.

Defrost whenever frost reaches a thickness of $\frac{1}{8}$ in. to $\frac{1}{4}$ in., as the frost acts as insulation and causes the compressor to run longer. Depending upon the unit, defrosting may be necessary every three months, or only once a year. Frost may be removed with a stiff-bristled or wire brush, or a plastic ice scraper, such as used on auto windshields; never use a sharp tool which might damage plates, coils or freezing surface. In top-opening freezers, frost may be found only in the upper part of the box. To remove this frost, take out only enough food to get down to the frost line, and spread papers over the remaining food to catch the frost as it is brushed off.

If the freezer is kept defrosted as recommended above, it should never be necessary to remove all the food and shut off current, much less to put pans of water in the freezer. This will only introduce more moisture in the air inside the freezer.

In the case of long neglect in defrosting, first try to remove frost by scraping or brushing as mentioned above. If frost can be removed in this way, nothing is to be gained by shutting off the current and letting the frost melt. This only serves to introduce moisture into the air in the freezer, and this moisture will freeze again when the compressor is started. In the event of heavy frosting, the frozen products should be removed, and wrapped in a heavy blanket, or several thicknesses of paper. If possible, they should be put in a refrigerator, or have dry ice wrapped in with them. Pans of water should not be placed in the freezer to melt frost.

Care of the exterior surface depends upon the type of finish. An enameled metal cabinet may be waxed. A wood cabinet should be repainted when necessary. It is a good plan to follow the manufacturer's instructions.

SERVICE AND RELIABILITY

It should be kept in mind that many large manufacturers not only build fine equipment, but train dealers and servicemen in order to insure satisfactory installation and operation of the equipment over a period of years; many small manufacturers with little or no dealer and sales organization will also make excellent equipment. Satisfactory operation

over a period of years will undoubtedly require some servicing. One should not recommend a product unless he can arrange for adequate servicing. Price alone should not be the determining factor in a sale. Special introductory offers should be carefully scrutinized.

An attractive looking unit is desirable, but a pleasing appearance does not guarantee satisfactory construction. Study the specifications and construction details before recommending any unit.

In order to go through doorways a unit should be not more than 30 in. wide. The height of a box which opens at the top should be not more than 36 in. Unless the outside wall is made of metal and well sealed at the joints, a vapor barrier should be placed inside the outer wall.

The walls should be of such material that they will hold their shape even in a damp location. If coils or plates are placed within the wall, the inner box, or lining, should be of metal and tightly sealed. The doors should fit well. There should be at least 5 in. of insulation of an accepted material in the walls, top and bottom. The doors should have at least 4 in. of insulation. Insufficient insulation means sweating walls and higher operating cost. If the construction of the wall is known, and it should be, the approximate amount of insulation can be determined by measuring the thickness of the wall structure—allowing for the thickness of the outer and inner walls.

Exposed coils are not as easily defrosted as plates, or smooth walls. Freon (F-12) seems to be the most desirable refrigerant, as it is non-toxic and odorless. The compressor has two jobs—it maintains constant low temperature within the box, and cools and freezes the products. To cool and freeze 100 lbs of beef from 60 F to 28 F, and to lower the temperature of the frozen beef to 0 F, a certain amount of heat must be removed from the beef (approximately 13,000 Btu). This will require the full output of a one-third hp compressor for 7 hours of continuous operation. Brine tanks or eutectic-filled plates will reduce this time or increase the freezing capacity. No arrangement of controls or the addition of other equipment will reduce the time of freezing or increase the capacity to any extent.

It would be desirable to have a unit that maintained a temperature differential of less than 2 F with not over 5 deg variation in any part of the cabinet. Another desirable feature for a farm freezer would be the ability to hold the temperature within 5 deg of zero, when loaded to 10 percent of capacity with unfrozen food.

GIVE MANAGEMENT ASSISTANCE

With an efficient unit, and good management, the user can expect to have a variety of satisfactory products throughout the year. Good management consists, first of all, in planning and executing a

complete freezing program. It may of course be necessary to make substitutions if a desired product is not available.

The manner of handling the packages is important. All packages should be labeled, dated and marked so that the product is easily identified. The program should be planned so that the freezing capacity is never exceeded.

Exceeding the freezing capacity of the unit is the greatest hazard of home freezing and is most likely to occur when freezing meat. This can be avoided by preparing only the recommended load and freezing it before preparing more. Packages freeze faster if placed against the wall or other freezing surfaces. Small packages freeze faster than larger ones. The less air in a package, the faster it will freeze; the food will also be of better flavor and nutritional quality. If the unit is equipped with a fan, packages should be stacked with at least half-inch spaces between them so that cold air can reach all the packages.

Suggest a storage system that will make each product easily available. Keeping a record of packages in and out, or taking an inventory and arranging packages every 2 or 3 months, will insure use of products within the optimum storage period, and will eliminate unnecessary hunting for packages.

A well-constructed frozen-food unit should give uninterrupted service for many years. Usually the owner is forewarned of trouble by noticing a rising temperature within the box, or the compressor running longer at a time than usual. For this reason, the unit should be equipped with a reliable thermometer placed near the top of the storage space so that the box temperature can be noted when products are removed. This temperature should be 0 F to minus 5 F. There is no advantage in storing at a lower temperature. Fluctuation of temperature during storage shortens the storage period and lessens palatability. It is well to note the box temperature every two days and investigate any rise in temperature, increased operation of the compressor or any unusual noise in the refrigerating mechanism. It should be kept in mind, however, that warm food placed in the unit will increase the temperature and operating time of the compressor, and food should therefore be chilled before being placed in the freezer. Also, compressor operation will increase noticeably in warm weather.

What to do if the power goes off may be of some concern to prospective owners. However, experience indicates that the owner should be more concerned about the accidental shutting off of power to the unit. While this may be caused by a blown fuse, it is usually due to failure to plug in the unit after dis-

connecting it. This is another and a good reason for noting the box temperature every few days.

IF FREEZER OPERATION IS INTERRUPTED

Electric power service seldom fails these days and then only for periods of seconds or minutes. Even a very unusual interruption of several hours would not normally cause food spoilage in the well-insulated freezers on the market today.

If the failure is in the household circuit or in the freezer mechanism and there is delay before repairs can be made, observe the following precautions.

Keep the freezer *closed* to conserve as much cold as possible. A well-filled freezer will keep most foods frozen for two or three days, the exact time depending on the room temperature. If dry ice is available (generally it can be obtained from ice cream and frozen food stores), arrange about 25 lb of ice on top of the frozen food packages.

If dry ice cannot be obtained and it seems likely that the service interruption will be for an extended period, it may be necessary to place the foods in containers and store them temporarily in a commercial frozen food locker.

If partial thawing has occurred before refrigeration is resumed, you can refreeze any packages in which some ice still remains. However, such packages should be used before those in which no thawing has occurred.

If complete thawing has occurred, various foods should be handled differently. Thawed fruits can be used for high-quality jams, jellies, sauces, or preserves.

Completely thawed meats, poultry, and fish should not be refrozen. If careful examination of each package shows that the contents still have a fresh odor, cook and use immediately.

If the family plans to be away from home for more than a few days, arrange with a neighbor to inspect the unit every other day. Suggest the places that an owner should call in case of trouble.

NEEDED ACCESSORIES

An alarm bell or light to indicate a dangerously high temperature of storage (+10 F) would add a considerable safety factor to the cabinet and is incorporated in some units.

A visible thermometer to show box temperature would help the user judge the condition and performance of his freezer and storage cabinet.

Spacers for the bottom of the cabinet may be used to keep the food from $\frac{1}{2}$ to 1 in. above the floor and to allow air circulation.

EFFECTS OF FREEZING ON FOODS

Each user of a farm freezing and storage cabinet or locker plant should be familiar with the five causes of changes in frozen foods and know what to do about each one. These five causes keep us constantly on the alert. They determine our results, depending upon how we handle the food we freeze and store.

The first of the five we know as bacteria, molds and yeasts. While they multiply rapidly at room temperatures, we slow them up when we hold vegetables and meats at 40 F. Little growth has been found at +15 F or lower. What does this mean to the farmer? It simply means that the farmer should handle products carefully, practice cleanliness, blanch or scald in boiling water or live steam to stop enzymatic action and cool the vegetables to around 40 F as soon as possible. If enzymatic action is not stopped by blanching or scalding, it creates changes in food flavor, color, food value and general quality.

The second cause of change in frozen foods is the chemical action of enzymes or ferments. These agents on the one hand do good, on the other do harm. They help ripen fruit and vegetables. Also, they cause them to get over-ripe and spoil. They help age beef during its 5 to 10 days in the chill room at 34 F to 36 F, yet help make fat pork rancid in a relatively few days. They cause off-flavors and unnatural colors in stored frozen food. Enzymes produce rapid changes at summer temperatures. They are less active at 40 F and have only slightly perceptible action at 0 F. No economical freezing temperature, however, will stop their action completely.

In order to slow up the action of enzymes, suggest to the farmer that vegetables be harvested, prepared, blanched or scalded according to instructions, then cooled as quickly as possible and frozen immediately.

Recommendations that locker plants and farm freezers be operated at 0 F are primarily based on enzyme action, and resulting quality of the food.

The third cause of change in stored food, "drying out" or "freezer burn" is quite different from that of bacteria or enzyme action. The air in most freezers is dry. This is a natural condition since the refrigerating coils freeze much moisture out of the air. Slowly and persistently, this dry air removes the moisture, in the form of ice, from exposed products, from poorly wrapped products and from products wrapped or packed in other than moisture-vapor proof packaging material. The dry, pithy tough looking surface that develops on some foods is called "freezer burn." To prevent this drying, much care is needed to select the proper vapor-proof paper or package and seal it correctly.

The fourth cause of change to consider is the ice formation in the food itself. When ordinary water

freezes, it tends to form pure ice, shoving aside the minerals or other substances that may be dissolved or suspended in it. When water in a vegetable or piece of meat freezes, it does much the same thing. It draws pure water to the ice crystals and leaves behind the coloring, flavor and food matter. This freezing itself produces changes in the food, some of which do not reform or come back to normal when the product thaws. If foods are frozen very slowly, the changes may involve even some tearing or rupturing of the cells and tissues as the ice crystals form and expand.

What can be done to get good results? Freeze foods as fast as possible. To freeze foods rapidly temperatures of 0 F and lower are needed. Some locker plants provide -10 F to -20 F for this purpose. Such low temperatures are not generally available in farm units and may never be practical from the standpoint of cost and economy.

Much can be done, however, to help speed freezing in a farm freezer. Some units are designed to use a fan in the freezing compartment. Place the package on or touching the freezing plates. Explain why packages should not be wrapped too heavily, as paper is an insulator, and do not make packages too large. Food in packages piled in still air will not freeze as fast as packages that are spread out or placed in moving air. The importance of moisture- and vapor-proof wrapping should be stressed.

A very important consideration that applies particularly to the farm and home freezer is—don't overload it with unfrozen food. These cabinets have very definite limits as to the number of pounds of products that they will freeze in 24 hours. An overload will not only cause slow freezing, but will raise the temperature of the frozen, stored materials, and therefore reduce their quality. Never place warm food in the freezer. All foods should first be chilled.

It is most important for each owner of a farm or home freezer unit to know its maximum freezing load and to be guided accordingly. It then follows that the nearby locker plant can render important service by freezing larger quantities of materials, and handling and freezing beef, lamb or veal.

The fifth and last consideration is the effect of storage time on the food. The longer frozen food is held, the more time there is for enzyme action, drying, and oxidation. A freezer unit should be a part of the family food-handling program. Encourage the farmer to provide space and use food so there will be room for meats, fruits and vegetables as they come along at the different seasons of the year.

FREEZING SUMMARIES

Refer to State Colleges, and Universities, County and Home Extension Agents and USDA information

for processing tables, recommended crop varieties, planting and freezing schedules and assist local educational agencies with educational programs.

TABLE III—APPROXIMATE STORAGE PERIOD OF FROZEN FOODS AT 0 F TO 10 F

Product	—Approximate Storage Period—		
	*0 F Months	5 F Months	10 F Months
Fruits, vegetables, beef, venison	10 to 12	8 to 10	3 to 4
Lamb, mutton, poultry, eggs	8 to 10	6 to 8	3 to 4
Pork, veal, creamery butter	6 to 8	4 to 6	2 to 3
Ground meat (unsalted)	4 to 6	3 to 4	1 to 2
Fish, ground meat with salt in seasoning	3 to 4	2 to 3	1 to 2

* Remember only 0 F is recommended.

Summary of the Fundamentals of Satisfactory Preservation of Meat by Freezing

1. Select good quality meat.
2. Be sure that the animal selected was slaughtered under sanitary conditions.
3. Be sure the carcass was promptly chilled and all animal heat removed as soon as possible after it was dressed.
4. Do not allow meat to freeze before cut and wrapped, ready for freezing.
5. Pork should be processed and frozen within 72 hours after it is dressed; lamb within 7 days; and beef within 10 days.
6. Store only quantities that can be used within limits of storage time recommended.
7. Select portions that are to be prepared for freezing.
8. Prepare only the amount that can be frozen at one time. Do not overload freezer. Preparation consists in removing all waste and dividing into family size portions.
9. Wrap very tightly in moisture-vapor-proof paper.
10. Freeze immediately.
11. Store within recommended temperature range.
12. Use meat according to planned schedule.

Summary of the Fundamentals of Satisfactory Preservation of Fruits by Freezing

1. Plan fruit freezing schedule. It may be adjusted from year to year in keeping with the supply of raw products.
2. Freeze only varieties recommended for freezing.
3. Select mature, ripe fruits of good quality.
4. Wash thoroughly—freezing does not sterilize products as canning does.
5. Blanch if blanching is recommended.
6. Add sugar or syrup according to directions. Do not use syrups heavier than 40–50 per cent, as heavier syrups will not freeze solid at 0 F.
7. Process immediately.
8. Makes packages family size.
9. Use moisture-vapor-proof packages, of heavy enough quality to support the weight of fruit plus syrup, thus preventing leakage. Exclude as much air as possible and seal tightly. Freeze immediately.

Summary of the Fundamentals of Satisfactory Preservation of Vegetables by Freezing

1. Freeze only varieties recommended for freezing.
2. Harvest vegetables when at their best.
3. Select good quality products. Freeze only amount called for in freezing schedule.
4. Prepare immediately after harvesting. Handle as rapidly as possible in order to retain quality.
5. Wash thoroughly, especially root crops.
6. Blanch in boiling water or live steam, and cool quickly.
7. Use moisture-vapor-proof packages. Exclude as much air as possible and seal tightly.
8. Freeze immediately.
9. Store within recommended temperature range.

PACKAGING FOODS FOR FREEZING

Stored frozen foods need not be sealed hermetically like canned products, but it is necessary to provide them with an efficient moisture-vapor-proof wrapping.

An ideal wrapping for frozen foods must resist the passage of moisture and vapor. It must be odorless and tasteless; easy to handle, seal and label; tough, so that it won't crack or puncture easily at zero temperature; economical of storage space and cheap enough to be practical. No existing wrapper or container possesses all these qualities. Each

home processor or locker-plant manager must select the one or ones best suited to the products handled, to the available storage conditions and to the length of the intended storage period. Various types of containers are available.

Containers

Glass jars with tops and rubber rings and tin cans with sealed or friction tops give efficient protection against drying and can be reused. They may be ex-

pensive to buy. They take up a good deal of space in the locker and glass jars are broken easily.

Special vapor-resistant cellophanes, films and latex films give almost as efficient protection as glass or tin. They are economical of space, can be heat-sealed easily, and the cellophanes and films make practical vapor-resistant liners for the more rigid, rugged pasteboard cartons. However, these films are relatively expensive, difficult to label unless special provision is made and are not punctureproof or tearproof when tumbled about in the locker.

Fiber cups or bags made of odorless, specially waxed or treated stock give excellent protection against drying, although those now available are not as efficient as latex and special cellophanes. Waxed containers are cheaper than those made from special films and are easier to fill and label. The wax coating often makes a fair seal as the lid of the container is pressed into place. Hot paraffin poured around the lid or sticky tape makes an additional seal.

Bags or containers made of laminated paper and other moisture-vapor-resistant materials are satisfactory especially if provided with a locking or sealing device.

Papers for Wrapping

Vapor-resistant cellophane makes an effective wrapping for frozen food. Its chief handicaps are that it is rather expensive, hard to handle and label, and needs protection from punctures and tearing.

Special, odorless waxed paper is widely used for wrapping frozen foods. Like the waxed cups, it will not prevent drying as effectively as the vapor-resistant films; it is cheaper, fairly tough, and reasonably efficient where storage periods last only a few months. The wax may crack where the paper is creased, and may chafe off if not protected. Ordinary waxed lunch paper, sold in grocery stores, is only fair protection against drying. If it must be used, double-wrap the product and seal the seams with special cold-storage tape.

Butcher paper or other untreated paper should not be placed against the food since it is hard to remove from the thawed product, may add undesirable flavors to the food, and gives little or no protection against drying. These non-moistureproof papers are useful only to prevent the tearing of an inner wrap.

In selecting the proper wrapping or container for frozen foods, give the best protection available to products to be stored for 6 months or longer, to fruits packed in dry sugar, or to vegetables not packed in brine. Use less effective, cheaper coverings for the others. Seasoned sausage should have airtight protection.

Packaging or Wrapping Foods

Foods should be prepared for freezing and divided

into such quantities as the farmer will wish to withdraw and use at one time. Sharp edges or corners should be removed from meat and poultry. Meat should be arranged in as compact a form as possible. This will save storage space and paper, and make wrapping easier.

Paper must be pulled tight against the meat, forcing out the air. Folding the two edges of the paper together, as a drug-store clerk wraps a box of candy, reduces air leakage through the seam. The ends of the paper should be folded together and rolled or folded tight against the food.

If the wrap can be heat-sealed, so much the better, Cold-storage tape is also used to close the seams.

When filling vegetables and fruits into cellophane bags that are to be heat-sealed, a funnel should be used so as to keep the sealing surface or lips of the bag clean. Foods should be settled compactly in containers, leaving about $\frac{1}{2}$ -in. headroom for expansion.

Heat Sealing

Cellophane, latex and some double-waxed paper can be heat-sealed by heating the top fold of the bag or the seams of the package with a moderately warm flatiron or curling iron. Just enough heat and pressure should be used to melt the paper or wax until it seals. If too much heat is used and the seal is scorched, a new seal or a new container should be substituted. If heat sealing is not possible, a good fold of the edges and sticky tape (not ordinary gummed tape) can be used. Careful wrapping and sealing are as important as good wrapping material.

Emergency Covers

A home-made bag can be made by heat-sealing the edges of strips of cellophane, latex or double-waxed paper. A strip of paper 7 X 21 in. will make a 6 X 10-in. bag with $\frac{1}{2}$ -in. folds along the seam and a 1-in. flap at the top.

A home-made, partially vapor-resistant covering for cans or jars can be made by dipping clean muslin into melted paraffin. The farmer should spread the cloth flat, let the wax harden and cut it into squares large enough to fit well down over the top and side of the can or jar. The square should be warmed slightly and pressed down snugly over the top of the filled can, then tied tightly with string. This waxed cloth must be handled carefully as it cracks easily.

Glazing

Glazing frozen food with pure water is another home-made wrap. This time the food is wrapped after it is frozen. Foods are first frozen in quantities or blocks desired for a single package. Then the block is dipped briefly in a pail or deep pan of clean water chilled to just above the freezing point. The

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zero temperature of the food will set a thin film of ice all over the food. The process is repeated every few minutes or as often as necessary to obtain a smooth glaze about $\frac{1}{16}$ in. thick. This ice covering will evaporate during storage and may have to be renewed every few months. It may also crack or chip off if handled roughly in storage. Wrapping the glazed food in paper will protect it considerably.

Fruits and vegetables may be glazed by being frozen in a smooth-lipped can or carton, warmed enough to be slipped from the can, refrozen and glazed like meat or poultry.

Labeling

Each package or container should be identified with the owner's locker number (if locker-plant service is used), the kind of product and date of storage. Special stamps, inks and pencils are made for labeling packages of frozen food. Ordinary lead pencils will not be effective unless the writing is done on strips of cold-storage tape stuck on the waxed coverings. Tags can be tied on if there is no other way. Wrapping paper or tape of different colors can be used to identify various products or different dates of storage.

HOME-BUILT UNITS AND ACCOMPANYING TECHNICAL DATA

Home-built frozen-food units are giving satisfactory service. More of these will be built. There may be a definite place for the home-built unit if the manufacturer finds that the demand for large units covers such a range of sizes that manufacturing costs will be prohibitive. Also there is the problem of shipping large units of 40 to 80 cu ft, and getting them through doors and into basements.

The home-built unit can be constructed where it is to be used, and can be made to fit a particular location. This is especially true with the walk-in type.

Certain fundamental requirements must be met in the home-built unit if it is to give years of satisfactory service. These requirements offer no serious problem to the careful builder, but they do represent a potential source of trouble. Much information can be had from the agricultural engineering departments of various state colleges and universities, manufacturers and dealers.

Factors in Design and Construction

Refrigeration requirements on individual farms will vary widely depending upon: (a) type of farm, (b) size of family, (c) kind of product to be stored and (d) length of storage period. The following important factors of design and construction might well be considered in the selection of equipment, regardless of whether the farmer expects to purchase a manufactured unit or plans to build one at the farm:

1. Temperatures required
2. Amount of storage space needed
 - Above freezing
 - Below freezing
3. Materials and type of construction
4. Insulation
 - Kind
 - Thickness
5. Refrigeration equipment
 - Size of compressor

Size and type of cooling coils
Controls

Temperatures to Be Maintained

The range of temperatures usually recommended for above-freezing compartments is from 32 F to 40 F. A room designed to maintain temperatures at 35 F or 36 F will give very satisfactory operation under farm conditions. Dairy products, meats, fruits and vegetables can be kept in good condition at this temperature for periods ranging from a few days up to 2 or 3 weeks. This temperature is also suitable for aging beef and curing pork.

It is generally recognized that the faster a product is frozen, the better is its quality. Common practice in the modern locker plant is to freeze at -15°F to -20°F . Commercial freezing is usually done at temperatures ranging from -20°F to -40°F . While there may be a slight loss in texture and appearance in products frozen at 0 F, it appears desirable that home-freezing equipment be designed to operate at this temperature because of the lower first cost and lower operating cost.

A temperature of 0 F is the maximum recommended for long time storage. Many frozen vegetables develop off-colors or undesirable flavors and lose much of the vitamin content within 4 to 6 months when stored at temperatures of 10 F to 15 F. Animal fat tends to turn rancid in 4 to 6 months when stored at these temperatures.

Space Required

The size of the above-freezing (35 F) compartment will depend upon the maximum amount of products to be stored at any one time. This will vary with the size of the family, and the amount of perishable products produced for market.

A room 6 ft wide, 8 ft long and 7 ft high will provide adequate space for 1 carcass each of beef, hog and lamb; 100 lb each of turkeys and chickens; 2

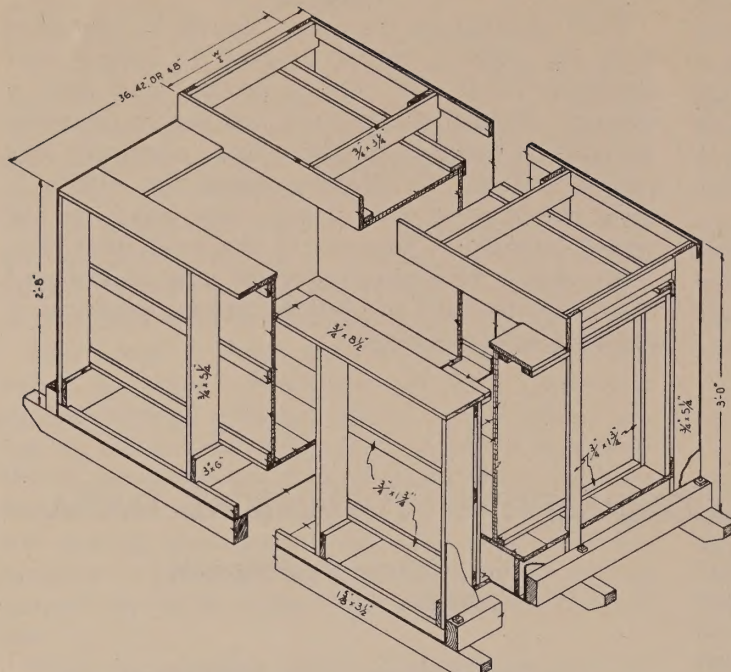


Fig. 4—Skeleton view of a 30 cu-ft home-built frozen food unit showing framing construction.

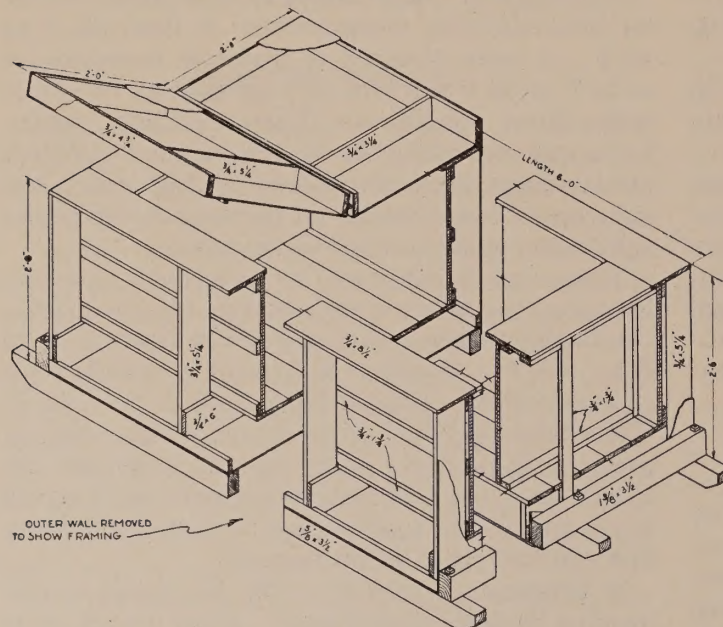


Fig. 5—The same unit as above with a removable top section so unit may be turned on its side to pass through doorways.

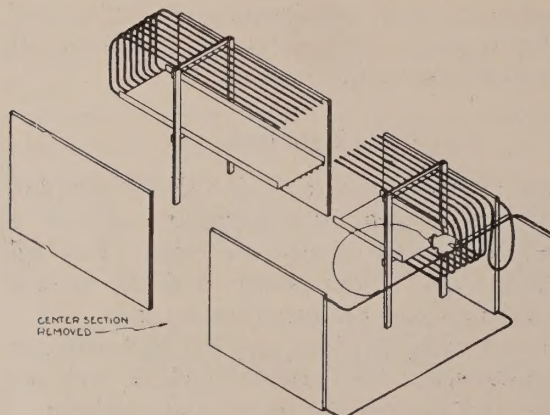


Fig. 9 (Left)—A view of the refrigeration coils using 21-in. plates for the front and back of the chest and $\frac{1}{2}$ -in. copper tubing for the freezing shelf. On chests with an overall length of 8 or more feet, two 12-in. plates can be used for the freezing shelf and the rear-21-in. plate may be omitted.

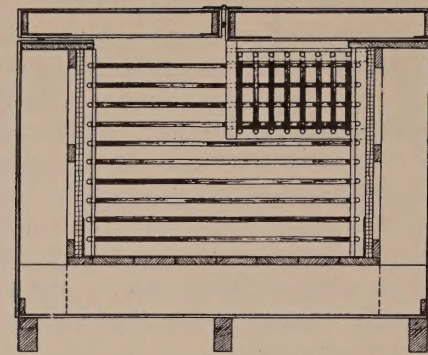


Fig. 6—End section-view of Fig. 5 showing location of refrigeration coils of the type shown in Fig. 8.

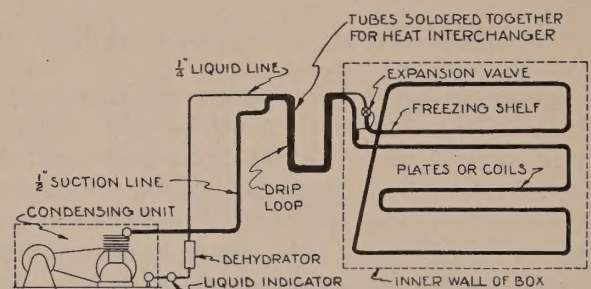


Fig. 7—Diagram of the refrigeration system used.

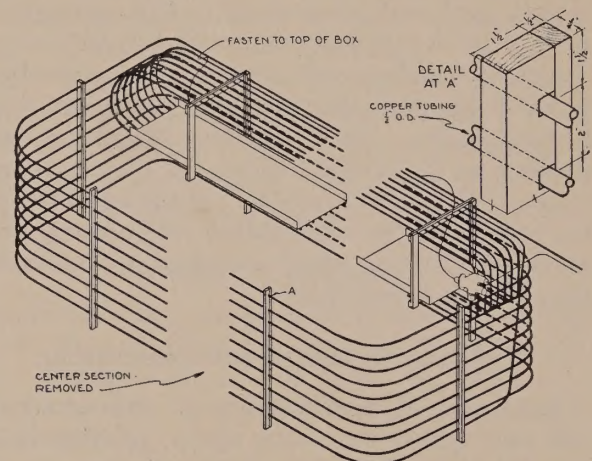


Fig. 8 (Above)—A view of the refrigeration coils using $\frac{1}{2}$ -in. copper tubing. It is the cheapest type of coil and fully satisfactory, but it is the most difficult to install.

The illustrations on this page are taken from Circular AE-22 (April 1947) with the courtesy of the Extension Service of the North Dakota Agricultural College and the U. S. Department of Agriculture.

crates of eggs; 2 cans of milk and 50 cu ft of miscellaneous products—in addition to the space required for a 25 cu ft freezer compartment.

The amount of frozen storage space required by individual families will vary widely, depending upon such factors as: (a) individual tastes, (b) food habits, (c) climatic conditions, and (d) the farm production program. The year's supply of meats, fruits and vegetables will ordinarily be stored in relatively large quantities during short periods of time; while products will be removed from storage in fairly uniform and small quantities week by week over the yearly period.

Type of Construction

If the refrigerator is to be constructed at the farm by a local carpenter, it is important that the type of construction desired be one with which he is familiar. It is equally important that all materials be available locally. Under these conditions standard frame construction is recommended.

One of the most important features in the construction of a refrigerator of this type is a vapor barrier in the outside wall. It is essential that the outside wall be made as nearly vapor-proof as possible. A double thickness of asphalt-impregnated paper, carefully applied with overlapping joints of at least 6 in. and sealed with liquid asphalt, will provide an effective moisture barrier.

The doors are especially important to the successful operation of a refrigerator. They should fit tightly and, should be strongly built to prevent sagging or warping after a few years' operation. A small leak around the door will materially increase the cost of operation. Double gaskets of hollow rubber may be used, with one on the face of the door and one on the door stop. These gaskets will conform to any slight irregularity in the fitting of the door and will insure a tight joint at all times. The inner gasket, however, often freezes tight. Some authorities now recommend only one gasket at the outer edge but want a well-fitted door.

Strong durable doors can be built by a fairly skilled carpenter at a considerable saving. However, if there is any question as to the carpenter's ability, it is recommended that commercially made doors be purchased. The door hardware, including hinges and fasteners, should be of substantial construction and of rust-resistant material. The fastener on the door to the chill room should be so constructed that the door can be opened from the inside.

The frozen-food compartment may be constructed either as a lift-top box or a side-opening box. The lift-top arrangement is somewhat easier to construct and very little warm air enters the box when the door is open. The side-opening freezer makes possible a better arrangement in the refrigerator and has the advantage of easier access.

The freezer compartment should be built inside the 35 F room with an air space allowed between the walls of this compartment and those of the 35 F room. This arrangement simplifies construction and improves operation of the refrigeration equipment by reducing heat leakage into the low-temperature compartment. It will also cause a small reduction in the total heat leakage.

Insulation

Insulation is perhaps the most important single feature of the refrigerator since it has an important bearing on the first cost of the box, the size of compressor needed and the cost of operation.

A good insulating material has a low heat conductivity factor; is resistant to moisture, fire and vermin, and does not absorb or give off odors readily. It should be comparatively low in cost and easy to install.

TABLE IV—INSULATING VALUE OF VARIOUS MATERIALS

Material	K*	Thickness in Inches to Equal 1-In. Cork
Corkboard	0.30	1.00
Rock cork	0.32	1.06
Mineral wool	0.31	1.03
Rock wool	0.28	0.93
Celotex	0.33	1.10
Fiberglass	0.27	0.90
Palco wool	0.25	0.83
Sawdust (dry)	0.41	1.36
Planer Shavings	0.41	1.36
Wood (pine)	1.03	3.43
Concrete	8.00	26.67

* K-Btu per hour per square foot per inch of thickness per degree F temperature difference.

Cork has long been accepted as a standard of quality in insulation. The major objection to the use of cork in farm refrigerators is the comparatively high cost. There are a number of less expensive insulating materials available which, if properly installed, will give excellent results.

Table IV gives the relative insulating value of several common materials.

The most economical thickness of insulation is determined by the relation between cost of construction and heat transmission through the walls. Under mean annual temperature conditions (70 F), the difference in heat losses through the walls of a 6 ft X 8 ft X 7 ft refrigerator with 4 in. and 6 in. of insulation operated at 35 F, is about 5,550 Btu per day. The extra 2 in. of insulation will reduce compressor operation 48.7 hr per month. This is a saving of approximately 351 kwhr per year. The extra cost of constructing the refrigerator with 6 in. of insulation is approximately \$24.00. The saving in operating cost with electricity at 3¢ per kwhr will pay for the extra investment in 2.3 years.

Savings in operating cost with 8 in. of insulation, as compared to 6 in., will take 6.7 years to pay for the extra investment. The savings in operating cost with 8 in. of insulation, as compared to 4 in., will repay the extra investment in 3.4 years.

The use of 8 in. of insulation would be justified on the basis of total annual operating cost. However, since the first cost is such an important factor in the acceptance of this equipment by the farmer, it is probable that 6 in. of insulation is the more practical thickness although there are many good reasons for recommending 8 in. to 10 in. more in warmer climates and less in colder climates.

A minimum of 3 in. of insulation should be used in the walls of a freezer compartment located inside the chill room. This amount is sufficient to prevent frost forming on the outside of the freezer compartment. Heat infiltration will not be sufficient to cause excessive cycling of the compressor.

Refrigeration Equipment

The size of the compressor will be determined by the maximum daily load. A $1\frac{1}{2}$ -hp air-cooled compressor operating 20 hr per day has sufficient capacity to handle the following peak load with 100 F air temperature, 35 F in chill room and 0 F in the freezer compartment.

Cool 500-lb products from 90 F to 35 F.....	24,750 Btu
Cool and freeze 60 lb from 60 F to 0 F.....	8,640
Total 24-hr load.....	59,310
Load per hour—20 hr operation.	2,966

Actual freezing and refrigeration requirements may be computed or, for general conditions, may be estimated from Table V.

There are several types of coils suitable for use in the chill room, operated at approximately 35 F.

These include pipe coils of copper or steel, plate coils, fin coils and fin coils with forced air circulation. Light-weight steel pipe coil, shaped and welded at a well-equipped steel plant or shop, can ordinarily be secured at a lower cost and is satisfactory for this service.

Cooling coils to be operated under low-temperature conditions in the freezer compartment should be either pipe coils or plate coils, since fin-type coils will frost over and operate at very low efficiency.

The ratio of plate surface area to motor should be about the same for other sizes as for the one mentioned above. A smaller amount of plate surface is often used because of design limitations and the use of a smaller compressor.

The controls should be specified by the refrigeration dealer who installs the equipment. Standard equipment in a 2-temperature refrigerator usually includes 2 expansion valves, 1 snap action valve, 2 three-way cut-off valves, a check valve in the suction line to the low-temperature coil and a pressure control. Standard accessories include a dehydrator and a scale trap at the bottom of the steel pipe coil in the 35 F room.

A surge tank installed in the suction line will reduce the cycling frequency of the compressor when operating on the small low-temperature coil.

The complete refrigeration system should be purchased from a reliable refrigeration dealer and installed by a competent workman.

A balanced refrigeration system should be able to maintain a temperature of zero (plus or minus 2) degrees Fahrenheit in a new cabinet. When no freezing is being done, it should be able to hold this temperature with the compressor operating not more than 16 out of the 24 hr on the hottest day in the year.

A refrigeration system in which all joints are welded or soldered is termed a "hermetically sealed system." This type of unit has no joints where re-

TABLE V—BTU TABLE FOR ESTIMATING NUMBER OF POUNDS OF FOOD UNIT IS ABLE TO FREEZE PER DAY

Approximate Btu Available per Hour for F-12 Air-Cooled Units, Room Temp 90 F and Average Low-Side Temp of -9 F		Freezing Capacity per Day Based on 50 Percent Running Time 0 F Cabinet Temp, Average -9 F Refrigerant Temp. * Check Manufacturer's Data, Obtain Operating Data or Calculate for Home-Built Cabinets		
1 Hp	2 Btu	3 Btu for Holding 0 F	4 Btu Available for Freezing*	5 Max. Lb per Day Freezing Capacity*
$\frac{1}{5}$	830	9,960	8,300	52
$\frac{1}{4}$	1,170	14,040	11,700	73
$\frac{1}{3}$	1,450	17,400	14,500	90
$\frac{1}{2}$	2,800	33,600	28,000	175
$\frac{3}{4}$	4,700	56,400	47,000	294
1	6,500	78,000	65,000	406
$1\frac{1}{2}$	8,800	105,600	88,000	550
2	11,200	134,400	112,000	700
3	13,500	162,000	135,000	843

* Taken from ASRE Food Freezer Standards as reported by the ASRE Committee of Food Freezer Standards, Section C, Freezing Capacity

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frigerant can leak out or air can enter. It needs practically no service and is less likely to give trouble. If trouble does occur, however, it is difficult to trace the cause and when one part is in need of repairs the whole system must be returned to the factory. Further, if a line should break, refrigerant and oil cannot be added by a local serviceman.

Open units have a separate motor which drives the compressor by means of a belt and pulleys, and the other parts of the system are connected to this compressor. This type of system requires service but is relatively easy to service. If something goes wrong with part of the system, only that part needs to be repaired or replaced, and usually this can be done by a local serviceman.

Freezing capacity shall be defined as the refrigeration available over and above that required to maintain the average freezer air temperature at 0 F in a 90 F ambient temperature. This is based upon the rated capacity of the condensing unit at 90 F ambient and the suction pressure required to maintain the freezer at the above conditions. It may be calculated by taking the percent running time required to maintain an empty freezer at 0 F in a room having 90 F ambient temperature and subtracting

from 100, then multiplying this value by the condensing unit capacity, for example, a unit having a capacity of 1,400 Btu per hr (manufacturer's rating) and 50 percent running time in the "no load" test with 90 F ambient and 0 F average freezer temperature, has 700 Btu per hr available for freezing. No single loading shall exceed 10 times the hourly freezing capacity based on the removal of a 160 Btu per lb for average foods.

Hold-Over Brine Tank

Some cabinets have a tank filled with brine which acts as a reserve supply of refrigeration for a short time. Such a tank offers some advantages but is generally expensive refrigeration except under special conditions. The development of portable brine tanks, the availability of dry ice, and equipment designed especially to maintain zero temperatures in freezing cabinets in emergencies will make it unnecessary for most people to buy a cabinet with a built-in brine tank. Brine enclosed in the refrigeration plates, however, will reduce temperature fluctuations in the cabinet and eliminate excessive cycling of a compressor—thus prolonging the life of the unit.

FARM ELECTRIFICATION MANUAL

SUMMARY CHECK-LIST FOR FREEZING CABINETS

(Sales, interviews, comparisons)

Cost	Cost, completely installed	_____	_____
	Price per cubic foot of capacity	_____	_____
Location	Maximum and minimum temperature of room	_____	_____
	Space—length, width	_____	_____
Size	Humidity in room	_____	_____
	Capacity—cu ft	_____	_____
Type	Clearance necessary for opening doors	_____	_____
	Length, width, height	_____	_____
Freezing	Chest, or front-opening	_____	_____
	Freezing, or holding only	_____	_____
Construction	Other combination	_____	_____
	Compartment-special	_____	_____
Refrigeration	Coil, plates or fan	_____	_____
	Brine or plate eutectic solution—amount	_____	_____
	Lids or doors with hinges	_____	_____
	Exterior finish—kind and color	_____	_____
	Gaskets—size, material	_____	_____
	Hardware—size and finish	_____	_____
	Insulation—kind	_____	_____
	Insulation—thickness-base, sides	_____	_____
	Insulation—thickness-top, doors	_____	_____
	Insulation—vaporproofing	_____	_____
	Insulation—sealed where tubing enters	_____	_____
	Interior finish and appearance	_____	_____
	Rust-proofed metal	_____	_____
	Skids, or other provision for moving	_____	_____
	Tubing insulated, cabinet to compressor	_____	_____
	Cabinet thermometer	_____	_____
	Defrosting—method	_____	_____
	Dehydrator—size	_____	_____
	Evaporator—coil, plate-size and amount	_____	_____
	Evaporator—blower capacity	_____	_____
	Heat exchanger	_____	_____
	Oil separator	_____	_____
	Receiver—capacity	_____	_____
	Refrigerant—kind of gas	_____	_____
	Sight glass	_____	_____
	Switch—pressure, or thermostatic	_____	_____
	Temperature warning device	_____	_____
	Unit—can it be removed from cabinet	_____	_____
	Unit—sealed, semi-sealed, or open	_____	_____
	Unit—air-cooled, or water-cooled	_____	_____
	Vibration and noise	_____	_____
	A-C or D-C	_____	_____
Electric Motor	Horsepower	_____	_____
	Type of overload protection	_____	_____
	Voltage and frequency	_____	_____
	A-C or D-C	_____	_____
Home Electrical Service	Meter voltage, frequency	_____	_____
	Branch circuit voltage at motor	_____	_____
Guarantee	Extent of coverage	_____	_____
	Length of time	_____	_____
	Reliability of dealer	_____	_____
	Reliability of manufacturer	_____	_____

FARM UTILIZATION COMMITTEE
EEI Commercial Division Farm Group
(1955-1956)

M. B. PENN, <i>Chairman</i> , Alabama Power Co.	T. F. HILDEBRAND, American Gas & Electric Service Corp.
W. T. ACKERMAN, The Connecticut Light & Power Co.	J. W. HOLT, Long Island Lighting Co.
RICH BAKES, The Washington Water Power Co.	W. B. KENNEDY, Central Illinois Light Co.
H. F. BARTON, St. Joseph Light & Power Co.	VIRGIL MARVIN, The Toledo Edison Co.
D. L. GARBER, The Dayton Power & Light Co.	R. E. MONINGER, Public Service Co. of Colorado
H. M. GIBBS, Texas Power & Light Co.	E. R. MURPHY, Kentucky Utilities Co.
R. G. HARVEY, Niagara Mohawk Power Corp.	L. S. SINGLEY, West Penn Power Co.
E. R. HEACOCK, Central Illinois Public Service Co.	J. S. WEBB, Philadelphia Electric Co.

Major credit for revising this section of the Manual should go to W. B. Kennedy, Central Illinois Light Co., Peoria, Illinois.
